In the Claims

This listing of claims, as required by 37 C.F.R. §1.121(c), replaces all prior versions of claims in the application. The 20 originally-filed claims have been withdrawn from consideration and 45 new claims added.

What is claimed is:

1. (withdrawn)

2. (withdrawn)

3. (withdrawn)

4. (withdrawn)

5. (withdrawn)

6. (withdrawn)

7. (withdrawn)

8. (withdrawn)

9. (withdrawn)

10. (withdrawn)

11. (withdrawn)

12. (withdrawn)

13. (withdrawn)

14. (withdrawn)

15. (withdrawn)

16. (withdrawn)

17. (withdrawn)

18. (withdrawn)

19. (withdrawn)

20. (withdrawn)

21. (new) A valve assembly comprising:

a solenoid coil adapted to generate a magnetic flux, and having a longitudinal axis and a bore coaxial therewith;

an axially translatable armature made of a magnetic material, said armature supported within an armature cavity for axial translation along said longitudinal axis;

a magnetic pole piece disposed within said bore of said solenoid coil, said magnetic pole piece having a lower distal end and being magnetically coupled to said armature and forming an axial air gap and a radial air gap between said armature and said lower distal end of said magnetic pole piece;

a valve unit, mechanically coupled to said armature, said valve unit having an interior valve poppet cavity in fluid communication with a fluid inlet port to which fluid is applied at a first fluid pressure and a fluid exit port from which said fluid is output at a second fluid pressure and containing a valve seat therebetween, said valve seat adapted to be closed by a valve closing assembly comprised of a valve poppet mechanically coupled to said armature, so as to regulate fluid flow between said fluid inlet port and said fluid exit port;

an armature centering mechanism to prevent off-axis tilting of said armature; and

a fluid pressure balancing arrangement adapted to compensate for said first fluid pressure and said second fluid pressure being exerted against said valve poppet, said fluid pressure balancing arrangement comprising a

diaphragm between said upper armature cavity and said interior valve poppet cavity and a fluid communication path through said valve closing assembly, said fluid communication path providing fluid communication between said fluid exit port and said upper armature cavity.

22. (new) The valve assembly according to claim 21, wherein said valve poppet further comprises a sealing ring disposed on a poppet face of said valve poppet to form a fluid-tight seal between said valve poppet and said valve seat in a manner that prevents fluid communication between said fluid inlet port and said fluid exit port.

23. (new) The valve assembly according to claim 21, wherein said armature is further comprised of a ferrule-shaped projection, said ferrule shaped projection of said armature forming said radial air gap between said magnetic pole piece and said armature.

24. (new) The valve assembly according to claim 21, wherein said lower distal end of said magnetic pole piece is further comprised of a ferrule-shaped projection, said ferrule-shaped projection forming said radial air gap between said magnetic pole piece and said armature.

25. (new) The valve assembly according to claim 21, wherein said magnetic pole piece is comprised of a sleeve piece portion and an axial portion, said sleeve piece portion further comprised of a relatively thin portion contiguous with said sleeve piece portion, said relatively thin portion rapidly saturating when said valve is subject to said magnetic flux and being magnetically coupled to said armature.

26. (new) The valve assembly according to claim 25, wherein said sleeve pole piece portion and said relatively thin portion of said magnetic pole piece are solid with a lower portion of said magnetic pole piece so that support for and axial alignment of said lower distal end of said magnetic pole piece relative to said armature is provided by said relatively thin portion and said sleeve pole piece portion of said magnetic pole piece continuous therewith, and is exclusive of a non-magnetic element.

27. (new) The valve assembly according to claim 25, wherein said relatively thin portion, said sleeve piece portion, and said lower portion of said magnetic pole piece are adapted to receive said solenoid coil.

28. (new) The valve assembly according to claim 25, wherein said sleeve piece portion of said magnetic pole piece further includes a radially inwardly projecting portion that is adjacent to, but radially spaced apart from, and magnetically coupled to said armature.

29. (new) The valve assembly according to claim 25, wherein said sleeve piece portion and said axial portion of said magnetic pole piece are configured to be one integral component.

30. (new) The valve assembly according to claim 25, wherein said axial portion of said magnetic pole piece is axially adjustable relative to said sleeve piece portion and said relatively thin portion of said magnetic pole piece.

31. (new) The valve assembly according to claim 30, wherein said sleeve piece portion and said axial portion of said magnetic pole piece are provided with a fluid seal therebetween.

32. (new) The valve assembly according to claim 21, wherein said assembly further includes a biasing member disposed substantially within said bore of said solenoid coil and between said magnetic pole piece and said armature for biasing said armature away from said lower distal end of said magnetic pole piece.

33. (new) The solenoid-actuated valve assembly according to claim 32, wherein said biasing member is a spring.

34. (new) The valve assembly according to claim 21, wherein said diaphragm has an annular area substantially the same as an annular area of said valve seat.

35. (new) The valve assembly according to claim 21, wherein said armature centering mechanism is a pair of spiral-configured suspension springs.

36. (new) The valve assembly according to claim 21, wherein said valve assembly further comprises an O-ring to prevent fluid leakage between said valve unit and said armature cavity.

37. (new) A solenoid-actuated valve assembly comprising:

a solenoid coil having a longitudinal axis and a solenoid bore coaxial therewith, said solenoid coil producing a magnetic flux;

a magnetic pole piece comprised of an axial portion, a lower distal end, and a sleeve piece portion, said magnetic pole piece supported within said solenoid bore and exclusive of the use of non-magnetic material;

an axially translatable armature made of a magnetic material, said armature being supported substantially within an armature cavity for axial translation along said longitudinal axis, said armature forming an axial gap and a

radial air gap with said magnetic pole piece, and said armature having an internal bore therethrough providing fluid communication with said solenoid bore;

a valve unit, mechanically coupled to said armature, said valve unit having an interior valve poppet cavity in fluid communication with a fluid inlet port to which fluid is applied at a first fluid pressure and a fluid exit port from which said fluid is output at a second fluid pressure and containing a valve seat therebetween, said valve seat adapted to be closed by a valve closing assembly comprised of a valve poppet mechanically coupled to said armature, so as to regulate fluid flow between said fluid inlet port and said fluid exit port;

an armature centering mechanism to prevent off-axis tilting of said armature;

a fluid pressure balancing arrangement adapted to compensate for said first fluid pressure and said second fluid pressure being exerted against said valve poppet, said fluid pressure balancing arrangement comprising a diaphragm between said upper armature cavity and said interior valve poppet cavity and a fluid communication path through said valve closing assembly, said fluid communication path providing fluid communication between said fluid exit port and said upper armature cavity; and

a spring disposed substantially within said solenoid bore of said solenoid coil and between said magnetic pole piece and said armature for biasing said armature away from said lower distal end of said magnetic pole piece.

38. (new) The solenoid-actuated valve assembly according to claim 37, wherein said valve poppet further comprises a sealing ring disposed on a poppet face of said valve poppet to form a fluid-tight seal between said valve poppet and said valve seat in a manner that prevents fluid communication between said fluid inlet port and said fluid exit port.

39. (new) The solenoid-actuated valve assembly according to claim 37, wherein said armature is further comprised of a ferrule-shaped projection, said ferrule shaped projection of said armature forming said radial air gap between said magnetic pole piece and said armature.

40. (new) The solenoid-actuated valve assembly according to claim 37, wherein said lower distal end of said magnetic pole piece is further comprised of a ferrule-shaped projection, said ferrule-shaped projection forming said radial air gap between said magnetic pole piece and said armature.

41. (new) The solenoid-actuated valve assembly according to claim 37, wherein said sleeve piece portion is further comprised of a relatively thin portion contiguous with said sleeve piece portion, said relatively thin portion rapidly saturating when said valve is subject to said magnetic flux and being magnetically coupled to said armature.

42. (new) The solenoid-actuated valve assembly according to claim 41, wherein said sleeve pole piece portion and said relatively thin portion of said magnetic pole piece are solid with a lower portion of said magnetic pole piece so that support for and axial alignment of said lower distal end of said magnetic pole piece relative to said armature is provided by said relatively thin portion and

said sleeve pole piece portion of said magnetic pole piece continuous therewith, and is exclusive of a non-magnetic element.

43. (new) The solenoid-actuated valve assembly according to claim 41, wherein said relatively thin portion, said sleeve piece portion, and said lower portion of said magnetic pole piece are adapted to receive said solenoid coil.

44. (new) The solenoid-actuated valve assembly according to claim 41, wherein said sleeve piece portion of said magnetic pole piece further includes a radially inwardly projecting portion that is adjacent to, but radially spaced apart from, and magnetically coupled to said armature.

45. (new) The solenoid-actuated valve assembly according to claim 41, wherein said sleeve piece portion and said axial portion of said magnetic pole piece are configured to be one integral element.

46. (new) The solenoid-actuated valve assembly according to claim 41, wherein said axial portion of said magnetic pole piece is axially adjustable relative to said sleeve piece portion and said relatively thin portion of said magnetic pole piece.

47. (new) The solenoid-actuated valve assembly according to claim 46, wherein said sleeve piece portion and said axial portion of said magnetic pole piece are provided with a fluid seal therebetween.

48. (new) The solenoid-actuated valve assembly according to claim 37, wherein said diaphragm has an annular area substantially the same as an annular area of said valve seat.

49. (new) The solenoid-actuated valve assembly according to claim 37, wherein said armature centering mechanism is a pair of spiral-configured suspension springs.

50. (new) The solenoid-actuated valve assembly according to claim 37, wherein said valve assembly further comprises an O-ring to prevent fluid leakage between said valve unit and said armature cavity.

51. (new) A valve assembly comprising:

a solenoid coil adapted to generate a magnetic flux, and having a longitudinal axis and a bore coaxial therewith;

an axially translatable armature made of a magnetic material, said armature supported within an armature cavity for axial translation along said longitudinal axis;

a magnetic pole piece disposed within said bore of said solenoid coil, said magnetic pole piece comprised of an axial portion, a lower distal end, and a sleeve piece portion, said magnetic pole piece being magnetically coupled to said armature and forming an axial air gap and a radial air gap between said armature and said lower distal end of said magnetic pole piece, and said sleeve piece portion further comprised of a relatively thin portion contiguous with said sleeve piece portion, said relatively thin portion rapidly saturating when said valve is subject to said magnetic flux;

a valve unit, mechanically coupled to said armature, said valve unit having an interior valve poppet cavity in fluid communication with a fluid inlet port to which fluid is applied at a first fluid pressure and a fluid exit port from

which said fluid is output at a second fluid pressure and containing a valve seat therebetween, said valve seat adapted to be closed by a valve closing assembly comprised of a valve poppet mechanically coupled to said armature, so as to regulate fluid flow between said fluid inlet port and said fluid exit port;

an armature centering mechanism to prevent off-axis tilting of said armature; and

a fluid pressure balancing arrangement adapted to compensate for said first fluid pressure and said second fluid pressure being exerted against said valve poppet, said fluid pressure balancing arrangement comprising a diaphragm between said upper armature cavity and said interior valve poppet cavity and a fluid communication path through said valve closing assembly, said fluid communication path providing fluid communication between said fluid exit port and said upper armature cavity.

52. (new) The valve assembly according to claim 51, wherein said valve poppet further comprises a sealing ring disposed on a poppet face of said valve poppet to form a fluid-tight seal between said valve poppet and said valve seat in a manner that prevents fluid communication between said fluid inlet port and said fluid exit port.

53. (new) The valve assembly according to claim 51, wherein said armature is further comprised of a ferrule-shaped projection, said ferrule shaped projection of said armature forming said radial air gap between said magnetic pole piece and said armature.

54. (new) The valve assembly according to claim 51, wherein said lower distal end of said magnetic pole piece is further comprised of a ferrule-shaped projection, said ferrule-shaped projection forming said radial air gap between said magnetic pole piece and said armature.

55. (new) The valve assembly according to claim 51, wherein said sleeve pole piece portion and said relatively thin portion of said magnetic pole piece are solid with a lower portion of said magnetic pole piece so that support for and axial alignment of said lower distal end of said magnetic pole piece relative to said armature is provided by said relatively thin portion and said sleeve pole piece portion of said magnetic pole piece continuous therewith, and is exclusive of a non-magnetic element.

56. (new) The valve assembly according to claim 51, wherein said relatively thin portion, said sleeve piece portion, and said lower portion of said magnetic pole piece are adapted to receive said solenoid coil.

57. (new) The valve assembly according to claim 51, wherein said sleeve piece portion of said magnetic pole piece further includes a radially inwardly projecting portion that is adjacent to, but radially spaced apart from, and magnetically coupled to said armature.

58. (new) The valve assembly according to claim 51, wherein said sleeve piece portion and said axial portion of said magnetic pole piece are configured to be one integral component.

59. (new) The valve assembly according to claim 51, wherein said axial portion of said magnetic pole piece is axially adjustable relative to said sleeve piece portion and said relatively thin portion of said magnetic pole piece.

60. (new) The valve assembly according to claim 59, wherein said sleeve piece portion and said axial portion of said magnetic pole piece are provided with a fluid seal therebetween.

61. (new) The valve assembly according to claim 51, wherein said assembly further includes a biasing member disposed substantially within said bore of said solenoid coil and between said magnetic pole piece and said armature for biasing said armature away from said lower distal end of said magnetic pole piece.

62. (new) The solenoid-actuated valve assembly according to claim 61, wherein said biasing member is a spring.

63. (new) The valve assembly according to claim 51, wherein said diaphragm has an annular area substantially the same as an annular area of said valve seat.

64. (new) The valve assembly according to claim 51, wherein said armature centering mechanism is a pair of spiral-configured suspension springs.

65. (new) The valve assembly according to claim 51, wherein said valve assembly further comprises an O-ring to prevent fluid leakage between said valve unit and said armature cavity.

In the Figures

Amendments to the Figures are attached hereto in Appendix C ("Amended Figures"). Figure 1 has been amended to include the phrase "Prior Art," per the Office Action's comments regarding same. Figure 2 has been amended to address the failings of the figure to comply with 37 C.F.R. 1.84(p)(5) as noted in paragraph 5 of page 2 of the Office Action, i.e., the addition of number 350 (annular groove) and more clearly show the numbers and those elements to which the elements are pointing. Figures 3 and 4 have been amended similarly so that they correspond with the changes made to Figure 2.

ARGUMENTS

The Examiner's Objections and Rejections

Applicant has noted the Office Action's objection, rejections, and bases for same. For the following reasons, Applicant respectfully submits that the amended and new claims are in a condition for allowance. Applicant respectfully requests that the Examiner consider the arguments and remarks as set forth below and pass the application to issuance.

1. 35 USC §112, First Paragraph Rejections

Claims 1 – 20

The Office Action has rejected claims 1 through 20 under 35 U.S.C. §112, first paragraph as being based on a disclosure which is not enabling. Specifically, the Office Action contends that the claims contain subject matter not described in the specification which would allow one of ordinary skill in the art to practice the invention. Applicant contends that the substitute specification and amendments to the claims as provided herein traverse this rejection.

2. 35 USC §102(b) Rejections

The Office Action relies on three patents as the prior art providing the bases for the 35 U.S.C. §102(b) rejections: Claims 1, 3, 4, and 15 are rejected under U.S. patent number 2,543,010 (Gardner '010), claims 1, 3, and 5 are rejected under U.S. Patent number 4,852,853 (Toshio '853), and claims 1 and 2 are rejected under U.S. Patent number 4,953,825 (Osumi '825).

Applicant contends that all of the claims rejected under 35 U.S.C. §102(b), regardless of the prior art reference, are in condition for allowance due to the fact that the prior art references do not teach each and every element of claims 1 - 5 and 15 as amended. For the reasons provided, Applicant respectfully requests that the 35 U.S.C. §102(b) rejection of claims 1 - 5 and 15 be withdrawn and these claims passed to allowance.

3. 35 USC §103(a) Rejections

Claims 16, 17, 19, and 20

The Office Action has also rejected claims 16, 17, 19, and 20 under 35 U.S.C. §103(a), specifically over Brehm '352 in view of Osumi '825. Applicant contends that these claims are in condition for allowance for the following reasons:

As the USPTO recognizes in MPEP §2142, "The examiner bears the initial burden of factually supporting any prima facie conclusion of obviousness. If the examiner does not produce a prima facie case, the applicant is under no obligation to submit evidence of non-obviousness." Thus, the burden rests on the Office Action to show the existence of prima facie obviousness, and if it cannot, the application should be passed to issuance.[1] As will be shown below, the Office Action does not show that prima facie obviousness exists.

That the Office Action asserts a 35 U.S.C. §103(a) rejection of the application presumes a difference between the invention and the valve of Brehm

[1] See also: "During patent examination the PTO bears the initial burden of presenting a prima facie case of patentability. ... If the PTO fails to meet this burden, then the applicant is entitled

'352. Otherwise a 35 U.S.C. §102 rejection would have been asserted with respect to these claims.

The specification of Brehm '352 does not teach or suggest modifying the embodiments disclosed therein so that the valve would further include a fluid flow restriction, i.e., a diaphragm, and an internal bore through the armature for the purpose of providing a solenoid-operated device pressure-balanced against both upstream and downstream fluid pressures. MPEP §2143.01 provides, "[t]he mere fact that references can be combined or modified does not render the resultant combination (or modification) obvious unless the prior art also suggests the desirability of the combination" or the modification. MPEP §2143.01, citing In re Mills, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990). Thus, obviousness cannot be established absent some teaching, suggestion, motivation, or incentive to make the modification, and there is no such teaching, suggestion, or incentive in the prior art to modify Brehm '352. As stated by the Federal Circuit in In re Gordon, "[t]he mere fact that the prior art *could* be so modified would not have made that modification obvious unless the prior art suggested the desirability of the modification." 733 F.2d 900, 902, 221 USPQ 1125, 1127 (Fed. Cir. 1984) (italics added).

The Brehm '352 valve is used primarily to control the pressure in a system in response to an electrical signal. On page 2 line 8 of the '352 patent, the summary characterizes the valve as an "electromagnetic valve, especially the pressurized medium regulating valve." Referring to the drawing of the '352

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to the patent." In re Glaug, 283 F.3d 1335, 1338, 62 USPQ2d 1151, 1152-53 (Fed. Cir. 2002) (citations omitted).

patent, it is readily observable that the solenoid force is acting against the fluid pressure force. Line 55 of column 4 provides:

> "The electromagnetic valve 10 is used in hydraulic bridge circuit as an electrically adjustable pressurized medium control valve in connection with the throttle portion 66. The pressure in the consuming device tube 68 corresponds to that resulting from a balancing of the pressurized medium force exerted on the valve stem 58 by the pressurized medium from the pressurized medium tube 55 and the force of the coil spring 40 acting on the valve stem 58 via the bearing bolt 36. When a current flows through the coil 15, the armature disk 23 is drawn toward the coil against the action of the coil spring 40. The force on the valve stem 58 due to the coil spring 40 is reduced thus by the magnetic force acting on the armature. The pressurized medium force from the pressurized medium tube 55 on the valve stem 58 required for force is thus reduced, i.e. the pressure in the consuming device tube 68 adjusts itself so that it is lower. Thus a falling excitation current-pressure characteristic curve can be realized with the electromagnetic valve according to the invention."

Thus, the pressure-reducing valve is used to maintain a reduced pressure in the outlet 68 in the direction of A connected to a consuming device in proportion to the applied electrical signal. The objective of the Brehm '352 valve

is to throttle the flow past the valve stem 58 into the tank port T, which is connected to a container, to maintain constant pressure on the outlet A. Brehm '352 thus teaches away from a flow control valve, as is the valve of the instant application, in which a steady flow is maintained across the valve for given inlet and outlet pressure conditions and a given electrical input signal.

In the Brehm '352 valve, the valve stem is required to axially translate based on the pressure fluctuations to vary the flow in order to maintain the constant regulated pressure on the outlet. In the valve of the instant application, it is necessary to make the valve opening constant, regardless of the pressure fluctuations, in order to maintain a constant flow. Thus, as is evidenced by the titles, the valve of the instant application is a flow control valve and the Brehm '352 valve is a pressure control valve. If the Brehm '352 valve design were pressure-balanced, it will not operate as a pressure control valve as it operates via force unbalance. The force generated by the solenoid coil in proportion to the input current is matched to the outlet pressure. Thus, as the electrical current is increased, a corresponding reduction in outlet pressure occurs, as explained on line 4 of column 5 of Brehm '352: "Thus a falling excitation current-pressure-characteristic curve can be realized with the electromagnetic valve according to the invention."

The valve of the instant application operates by eliminating force unbalance and creating axial displacement of the armature and fluid flow through the valve in proportion to current. As the electrical input signal is increased, a

corresponding increase in flow occurs. That is, Brehm '352 design teaches away from pressure-balancing.

Moreover, if Brehm '352 were modified to act as a pressure-balancing valve, it would be modified beyond its intended purpose. It is well-settled that

> "[i]f the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious." MPEP §2143.01.[2]

Thus, because the Office Action's reliance of Brehm '352 in view of Osumi '825 modifies the operation of Brehm '352 beyond its intended function, the 35 U.S.C. §103(a) rejection of claims 16, 17, 19, and 20 is inappropriate.

Finally, with respect to Brehm '352, the Brehm '352 valve will not operate, i.e. control the pressure on the output, if the third container, or T port, is absent. That is, the Brehm '352 valve <u>requires</u> a total of three fluid ports for proper operation of the valve, due to the basic nature of pressure regulating valves. The valve of the instant application, on the other hand, uses only two ports, namely, an inlet and outlet port.

In addition, the structure of the Osumi '825 valve is more like a conventional on/off solenoid than a proportional solenoid. Referring to Figure 1 of Osumi '825, there is only one active air gap, namely, the axial air gap between the armature face (3d) and the opposing face on the pole piece (5a). Despite Osumi '825's title, claims, and characterization in the written description that is a

[2] See also MPEP §2145(III) ("the claimed combination cannot change the principle of operation of the primary reference or render the reference inoperable for its intended purpose.") and *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984) ("If a proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification.").

proportional valve, this will produce a highly non-linear solenoid characteristic, which in turn will produce a non-linear valve flow performance, since a flow control valve of the type described, exactly follows the characteristics of the solenoid.

The Osumi '825 valve acts as a conventional on/off valve as it is a variable air gap device. That is, as the armature axially translates, of the gap between the armature and the pole piece, and the corresponding distance across which the magnetic flux must travel, changes. The configuration of the present valve employs a radial air gap between the armature and the pole piece such that as the armature axially translates, the radial air gap between the armature and the pole piece, i.e., the path taken by the magnetic flux in the radial direction, remains constant. This allows the linear relationship between displacement of the armature and current applied, which the Osumi '825 valve lacks.

This is further described in Applicant's earlier US patent, number 4,954,799 (Kumar '799) and the accompanying technical explanation of proportional solenoids in the 1990-91 Fluid Power Handbook & Directory. Figure 30 of the Kumar '799 patent shows how a typical solenoid has non-linear characteristics in which the solenoid force generated by applying various electrical currents against air gap is plotted. When this armature force is superimposed against a biasing spring, the resulting armature displacement against current is as shown in Figure 31 of Kumar '799. Such a valve produces a non-linear flow curve, which results in an on/off operation of the valve instead of a smooth proportional valve.

This same explanation with respect to proportionality versus on/off valve operation is given in Figure 18 of the article from the Fluid Power Handbook & Directory. A true proportional solenoid valve requires the force characteristics shown in Figure 32 of the Kumar '799 patent. The proportional zone, or flat portion, of the solenoid characteristic, when superimposed with the biasing spring characteristic, yields the linear displacement versus current characteristic as shown in Figure 33. The same is explained in the bottom half of the figure 18 of the Fluid Power Handbook & Directory. This type of performance is accomplished by carefully designing the solenoid magnetic path as shown in Figure 34 of the Kumar '799 patent.

As shown in Figure 2 of the instant application, two working air gaps are formed between the armature and the magnetic pole piece: one of these air gaps is the axial air gap and the other is the radial air gap (also similarly described in the Fluid Power Handbook & Directory). The axial air gap 335 is between the lower face of the magnetic pole piece and the upper surface of the armature. The radial air gap is between the outer cylindrical surface of the armature sleeve and the interior cylindrical surface of the ferrule-shaped projection of the magnetic pole piece.

As can be seen, the structure of the instant application is quite different from that of Osumi '825. In Osumi '825, there is only an axial air gap between the armature and the pole piece and no radial air gap. In a valve according to the instant application, when an electrical signal is applied to the solenoid coil, the magnetic flux path occurs between the armature and the pole piece, not only

in the axial direction (across the axial air gap), but also in the radial direction (across the radial air gap). The radial air gap 235, a path of low reluctance, shunts a portion of the magnetic flux that normally passes across axial air gap, a path of relatively high reluctance.

When the coil is energized, the magnetic flux of the resulting magnetic field follows a closed path through the magnetic pole piece, partially across the axial air gap and partially across the radial air gap, through the ferrule-shaped portion of the armature, to the housing, and back to the magnetic pole piece. The result is an effective constant force characteristic over a prescribed armature displacement, irrespective of the relative axial separation between the armature and the end of the magnetic pole piece.

In addition, structurally, if the armature according to a valve of the instant application is not held firmly in the radial direction (i.e., perpendicular to the direction of travel), the armature will move toward the radially inward projection of the pole piece. If this were to happen, the radial attractive force exponentially increases since the force is inversely proportional to the square of the distance. Once this occurs, the armature continues to move and attaches itself to the internal surface of the pole piece. In order to avoid this, the instant application maintains the l/d (length to diameter) ratio of the armature low and uses two flat spiral metal springs to restrain the armature from radial movement.

Osumi '825 uses a metal diaphragm 2 not only to isolate the solenoid chamber from the main flow path, but also to restrain the armature from radial movement relative to the pole piece. This is possible because there is no radial

magnetic flux at the distal end of the armature in proximity to the pole piece that would act as a torque on the armature. If such an arrangement is used with a radial air gap required in a proportional valve like that of the instant application, the twisting due to radial forces would be significant.

If the valve of the instant application were to be constructed with only one metal diaphragm, as the Osumi '825 valve is, once the electrical signal is applied, the single metal diaphragm twists and the armature is likely to stick to the radial face of the pole piece, thus physically making the device inoperable. That is, if a valve includes an axial air gap and a radial air gap, there must be multiple diaphragms or their equivalents. Thus, the Osumi '825 valve is useful only as a valve with on/off performance characteristics.

Thus, because neither Brehm '352 nor Osumi '825 provide any teaching, incentive, suggestion, or motivation to modify the valve disclosed therein to produce the valve of the instant application, the Office Action has not met its burden of prima facie obviousness. In addition, because the Osumi '825 valve has the solenoid characteristics and structure of an on/off valve, it is non-analogous prior art. Thus, the 35 U.S.C. §103(a) rejection of claims 16, 17, 18, and 19 is unsupported by the art cited in the Office Action. For the reasons provided, Applicant respectfully requests that the rejection of claims 16, 17, 18, and 19 be withdrawn and these claims as amended passed to allowance.

Claims 16, 17, and 18

The Office Action has also rejected claims 16, 17, and 18 under 35 U.S.C. §103(a), specifically over Brehm '352 in view of Toshio '853. Applicant contends that these claims are in condition for allowance for the following reasons:

As the USPTO recognizes in MPEP §2142, "The examiner bears the initial burden of factually supporting any prima facie conclusion of obviousness. If the examiner does not produce a prima facie case, the applicant is under no obligation to submit evidence of non-obviousness." Thus, the burden rests on the Office Action to show the existence of prima facie obviousness, and if it cannot, the application should be passed to issuance.[3] As will be shown below, the Office Action does not show that prima facie obviousness exists.

That the Office Action asserts a 35 U.S.C. §103(a) rejection of the application presumes a difference between the invention and the valve of Brehm '352. Otherwise a 35 U.S.C. §102 rejection would have been asserted with respect to these claims.

The specification of Brehm '352 does not teach or suggest modifying the embodiments disclosed therein so that the valve would further include a fluid flow restriction, i.e., a diaphragm, and an internal bore through the armature for the purpose of providing a solenoid-operated device pressure-balanced against both upstream and downstream fluid pressures. MPEP §2143.01 provides, "[t]he mere fact that references can be combined or modified does not render the resultant combination (or modification) obvious unless the prior art also suggests

[3] See also: "During patent examination the PTO bears the initial burden of presenting a prima facie case of patentability. ... If the PTO fails to meet this burden, then the applicant is entitled to the patent." In re Glaug, 283 F.3d 1335, 1338, 62 USPQ2d 1151, 1152-53 (Fed. Cir. 2002) (citations omitted).

the desirability of the combination" or the modification. MPEP §2143.01, citing In re Mills, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990). Thus, obviousness cannot be established absent some teaching, suggestion, motivation, or incentive to make the modification, and there is no such teaching, suggestion, or incentive in the prior art to modify Brehm '352. As stated by the Federal Circuit in In re Gordon, "[t]he mere fact that the prior art *could* be so modified would not have made that modification obvious unless the prior art suggested the desirability of the modification." 733 F.2d 900, 902, 221 USPQ 1125, 1127 (Fed. Cir. 1984) (italics added).

The Brehm '352 valve is used primarily to control the pressure in a system in response to an electrical signal. On page 2 line 8 of the '352 patent, the summary characterizes the valve as an "electromagnetic valve, especially the pressurized medium regulating valve." Referring to the drawing of the '352 patent, it is readily observable that the solenoid force is acting against the fluid pressure force. Line 55 of column 4 provides:

> "The electromagnetic valve 10 is used in hydraulic bridge circuit as an electrically adjustable pressurized medium control valve in connection with the throttle portion 66. The pressure in the consuming device tube 68 corresponds to that resulting from a balancing of the pressurized medium force exerted on the valve stem 58 by the pressurized medium from the pressurized medium tube 55 and the force of the coil spring 40 acting on the valve stem 58 via the bearing bolt 36. When a current flows through the coil

15, the armature disk 23 is drawn toward the coil against the action of the coil spring 40. The force on the valve stem 58 due to the coil spring 40 is reduced thus by the magnetic force acting on the armature. The pressurized medium force from the pressurized medium tube 55 on the valve stem 58 required for force is thus reduced, i.e. the pressure in the consuming device tube 68 adjusts itself so that it is lower. Thus a falling excitation current-pressure characteristic curve can be realized with the electromagnetic valve according to the invention."

Thus, the pressure-reducing valve is used to maintain a reduced pressure in the outlet 68 in the direction of A connected to a consuming device in proportion to the applied electrical signal. The objective of the Brehm '352 valve is to throttle the flow past the valve stem 58 into the tank port T, which is connected to a container, to maintain constant pressure on the outlet A. Brehm '352 thus teaches away from a flow control valve, as is the valve of the instant application, in which a steady flow is maintained across the valve for given inlet and outlet pressure conditions and a given electrical input signal.

In the Brehm '352 valve, the valve stem is required to axially translate based on the pressure fluctuations to vary the flow in order to maintain the constant regulated pressure on the outlet. In the valve of the instant application, it is necessary to make the valve opening constant, regardless of the pressure fluctuations, in order to maintain a constant flow. Thus, as is evidenced by the titles, the valve of the instant application is a flow control valve and the Brehm

'352 valve is a pressure control valve. If the Brehm '352 valve design were pressure-balanced, it will not operate as a pressure control valve as it operates via force unbalance. The force generated by the solenoid coil in proportion to the input current is matched to the outlet pressure. Thus, as the electrical current is increased, a corresponding reduction in outlet pressure occurs, as explained on line 4 of column 5 of Brehm '3542: "Thus a falling excitation current-pressure-characteristic curve can be realized with the electromagnetic valve according to the invention."

The valve of the instant application operates by eliminating force unbalance and creating axial displacement of the armature and fluid flow through the valve in proportion to current. As the electrical input signal is increased, a corresponding increase in flow occurs. That is, Brehm '352 design teaches away from pressure-balancing.

Moreover, if Brehm '352 were modified to act as a pressure-balancing valve, it would be modified beyond its intended purpose. It is well-settled that

> "[i]f the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious." MPEP §2143.01.[4]

Thus, because the Office Action's reliance of Brehm '352 in view of Osumi '825 modifies the operation of Brehm '352 beyond its intended function, the 35 U.S.C. §103(a) rejection of claims 16, 17, 19, and 20 is inappropriate.

[4] See also MPEP §2145(III) ("the claimed combination cannot change the principle of operation of the primary reference or render the reference inoperable for its intended purpose.") and *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984) ("If a proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification.").

Finally, with respect to Brehm '352, the Brehm '352 valve will not operate, i.e. control the pressure on the output, if the third container or T port is absent. That is, the Brehm '352 valve <u>requires</u> a total of three fluid ports for proper operation of the valve, due to the basic nature of pressure regulating valves. The valve of the instant application, on the other hand, uses only two ports, namely, an inlet and outlet port.

In addition, with respect to Toshio '825, in a proportional valve like the one of the instant application, an O-Ring (7) like the one used by Toshio '825 between cover (4) and sleeve (3), will lead to high amounts of friction between the two components as poppet valve (2) and sleeve (3) axially translate when the solenoid coil (6) is energized, resulting in a large hysteresis, which is undesirable for proportionality. Thus, while the Toshio '825 valve is pressure-balanced, it is not a proportional valve.

In the instant application, the diaphragm used to prevent fluid flow flexes up and down as the armature travels and therefore eliminates the friction characteristics of the O-Ring. Eliminating the O-ring also increases the frequency response characteristics of the valve. The design of the instant application accommodates a diaphragm design and improves performance of the proportional flow control valve. O-Ring type seals are only acceptable for less precise valves, i.e., on/off valves, and are not acceptable in precision controlled closed loop systems, where fast response and incremental controls are required, as in the valve of the instant application. Use of the diaphragm in the valve of the instant application permits proportionality, which the Toshio '853 valve lacks.

One of ordinary skill in the prior art would not look to Toshio '853 to solve the problems of Brehm '352 to achieve the valve of the instant application. Thus, Toshio '853, an on/off valve is non-analogous prior art.

Thus, because neither Brehm '352 nor Toshio '853 provide any teaching, incentive, suggestion, or motivation to modify the valve disclosed therein to produce the valve of the instant application, the Office Action has not met its burden of prima facie obviousness. In addition, because the Toshio '853 valve has the solenoid characteristics and structure of an on/off valve, it is non-analogous prior art. Thus, the 35 U.S.C. §103(a) rejection of claims 16, 17, and 18 is unsupported by the art cited in the Office Action. For the reasons provided, Applicant respectfully requests that the rejection of claims 16, 17, and 18 be withdrawn and these claims as amended passed to allowance.

<u>4. Double Patenting Rejections</u>

Claims 6-13

The Office Action has rejected claims 6 - 13 as double patenting. Specifically, the Office Action has rejected claims 6 - 13 as being unpatentable over claims 1, 3 - 7, and 11 - 13 of U.S. Patent No. 6,604,726 (Kumar '726) in view of Osumi '825. Applicant respectfully traverses these rejections for the following reasons:

As the MPEP recognizes, "[a] double patenting rejection of the obviousness-type is 'analogous to [a failure to meet] the nonobvious requirement of 35 U.S.C. 103' except that the patent principally underlying the double patenting rejection is not considered prior art." MPEP §804 II.B.1 citing *In re*

Braithwait, 379 F.2d 594, 154 USPQ 29 (CCPA 1967). That section of the MPEP continues, "[t]herefore, any analysis employed in an obvious-type double patenting determination parallels the guidelines for analysis of a 35 U.S.C. 103 obviousness determination." MPEP §804 II.B.1 citing *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985). Thus, as the USPTO recognizes in MPEP §2142, "[t]he examiner bears the initial burden of factually supporting any prima facie conclusion of obviousness. If the examiner does not produce a prima facie case, the applicant is under no obligation to submit evidence of non-obviousness." That is, the burden rests on the Office Action to show the existence of prima facie obviousness, and if it cannot, the application should be passed to issuance.[5] As will be shown below, the Office Action does not show that prima facie obviousness exists.

That the Office Action asserts a double patenting type rejection of the application presumes a difference between the invention and the valve of Kumar '726. Otherwise a 35 U.S.C. §102 rejection would have been asserted with respect to these claims.

The written description of Kumar '726 does not suggest, teach, or provide the incentive for modifying the embodiments disclosed therein so that the valve would further include a fluid pressure balancing arrangement as shown in Osumi '825. MPEP §2143.01 provides, "[t]he mere fact that references can be combined or modified does not render the resultant combination (or modification)

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[5] See also: "During patent examination the PTO bears the initial burden of presenting a prima facie case of patentability. ... If the PTO fails to meet this burden, then the applicant is entitled to the patent." In re Glaug, 283 F.3d 1335, 1338, 62 USPQ2d 1151, 1152-53 (Fed. Cir. 2002) (citations omitted).

obvious unless the prior art also suggests the desirability of the combination" or the modification. MPEP §2143.01, citing In re Mills, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990). Thus, obviousness cannot be established absent some teaching, suggestion, motivation, or incentive to make the modification, and there is no such teaching, suggestion, or incentive in the prior art to modify Kumar '726 or Osumi '825. As stated by the Federal Circuit in In re Gordon, "[t]he mere fact that the prior art *could* be so modified would not have made that modification obvious unless the prior art suggested the desirability of the modification." 733 F.2d 900, 902, 221 USPQ 1125, 1127 (Fed. Cir. 1984) (italics added). Thus, an obvious-type double patenting rejection of the instant application in which the Office Action relies on Kumar '726 in view of Osumi '825 in improper.

In addition, the structure of the Osumi '825 valve is more like a conventional on/off solenoid than a proportional solenoid. Referring to Figure 1 of Osumi '825, there is only one active air gap, namely, the axial air gap between the armature face (3d) and the opposing face on the pole piece (5a). Despite Osumi '825's title, claims, and characterization in the written description that is a proportional valve, this will produce a highly non-linear solenoid characteristic, which in turn will produce a non-linear valve flow performance, since a flow control valve of the type described, exactly follows the characteristics of the solenoid.

The Osumi '825 valve acts as a conventional on/off valve as it is a variable air gap device. That is, as the armature axially translates, the thickness of the gap between the armature and the pole piece, and the corresponding distance

across which the magnetic flux must travel, changes. The configuration of the present valve employs a radial air gap between the armature and the pole piece such that as the armature axially translates, the air gap between the armature and the pole piece, i.e., the path taken by the magnetic flux, remains constant. This allows the linear relationship between displacement of the armature and current applied, which the Osumi '825 valve lacks.

This is further described in Applicant's earlier US patent, number 4,954,799 (Kumar '799) and the accompanying technical explanation of proportional solenoids in the 1990-91 Fluid Power Handbook & Directory. Figure 30 of the Kumar '799 patent shows how a typical solenoid has non-linear characteristics in which the solenoid force generated by applying various electrical currents against air gap is plotted. When this armature force is superimposed against a biasing spring, the resulting armature displacement against current is as shown in Figure 31 of Kumar '799. Such a valve produces a non-linear flow curve, which results in an on/off operation of the valve instead of a smooth proportional valve.

This same explanation with respect to proportionality versus on/off valve operation is given in Figure 18 of the article from the Fluid Power Handbook & Directory. A true proportional solenoid valve requires the force characteristics shown in Figure 32 of the Kumar '799 patent. The proportional zone, or flat portion, of the solenoid characteristic, when superimposed with the biasing spring characteristic, yields the linear displacement versus current characteristic as shown in Figure 33. The same is explained in the bottom half of the figure 18 of

the Fluid Power Handbook & Directory. This type of performance is accomplished by carefully designing the solenoid magnetic path as shown in Figure 34 of the Kumar '799 patent.

As shown in Figure 2 of the instant application, two working air gaps are formed between the armature and the magnetic pole piece: one of these air gaps is the axial air gap and the other is the radial air gap (also similarly described in the Fluid Power Handbook & Directory). The axial air gap 335 is between the lower face of the magnetic pole piece and the upper surface of the armature. The radial air gap is between the outer cylindrical surface of the armature sleeve and the interior cylindrical surface of the ferrule-shaped projection of the magnetic pole piece.

As can be seen, the structure of the instant application is quite different from that of Osumi '825. In Osumi '825, there is only an axial air gap between the armature and the pole piece and no radial air gap. In a valve according to the instant application, when an electrical signal is applied to the solenoid coil, the magnetic flux path occurs between the armature and the pole piece, not only in the axial direction (across the axial air gap), but also in the radial direction (across the radial air gap). The radial air gap 235, a path of low reluctance, shunts a portion of the magnetic flux that normally passes across axial air gap, a path of relatively high reluctance.

When the coil is energized, the magnetic flux of the resulting magnetic field follows a closed path through magnetic pole piece, partially across the axial air gap and partially across the radial air gap, through the ferrule-shaped portion

of the armature, to the housing, and back to the magnetic pole piece. The result is an effective linearization of the force versus electrical signal characteristic over a prescribed range, irrespective of the relative axial separation between the armature and the end of the magnetic pole piece.

Moreover, the fact that the ferrule-shaped portion of the armature is tapered, or has a varying thickness in the axial direction, causes this portion of the armature to become progressively saturated in the course of its diverting magnetic flux causing the force imparted by the coil on the armature to vary in proportion to the applied signal, so that axial displacement of the armature against the bias of the spring varies in proportion to the signal.

In addition, structurally, if the armature according to a valve of the instant application is not held firmly in the radial direction (i.e., perpendicular to the direction of travel), the armature will move toward the radially inward projection of the pole piece. If this were to happen, the radial attractive force exponentially increases since the force is inversely proportional to the square of the distance. Once this occurs, the armature continues to move and attaches itself to the internal surface of the pole piece. In order to avoid this, the instant application maintains the l/d (length to diameter) ratio of the armature low and uses two flat spiral metal springs to restrain the armature from radial movement.

Osumi '825 uses a metal diaphragm 2 not only to isolate the solenoid chamber from the main flow path, but also to restrain the armature from radial movement relative to the pole piece. This is possible because there is no radial magnetic flux at the distal end of the armature in proximity to the pole piece that

would act as a torque on the armature. If such an arrangement is used with a radial air gap required in a proportional valve like that of the instant application, the twisting due to radial forces would be significant.

If the valve of the instant application were to be constructed with only one metal diaphragm, as the Osumi '825 valve is, once the electrical signal is applied, the single metal diaphragm twists and the armature is likely to stick to the radial face of the pole piece, thus physically making the device inoperable. That is, if a valve includes an axial air gap and a radial air gap, there must be multiple diaphragms or their equivalents. Thus, the Osumi '825 valve is useful only as a valve with on/off performance characteristics and is non-analogous prior art.

Thus, because neither Kumar '726 nor Osumi '825 provide any teaching, incentive, suggestion, or motivation to modify the valves disclosed therein to produce the valve of the instant application, the Office Action has not met its burden of prima facie obviousness for a double patenting rejection. In addition, for the reasons provided supra, because the Osumi '825 valve is useful only as a valve with on/off performance characteristics, it is non-analogous prior art. Thus, the obvious-type double patenting rejection of claims 6 - 13 is unsupported by the art relied upon in the Office Action. For the reasons provided, Applicant respectfully requests that the rejection of claims 6-13 be withdrawn and these claims passed to allowance.